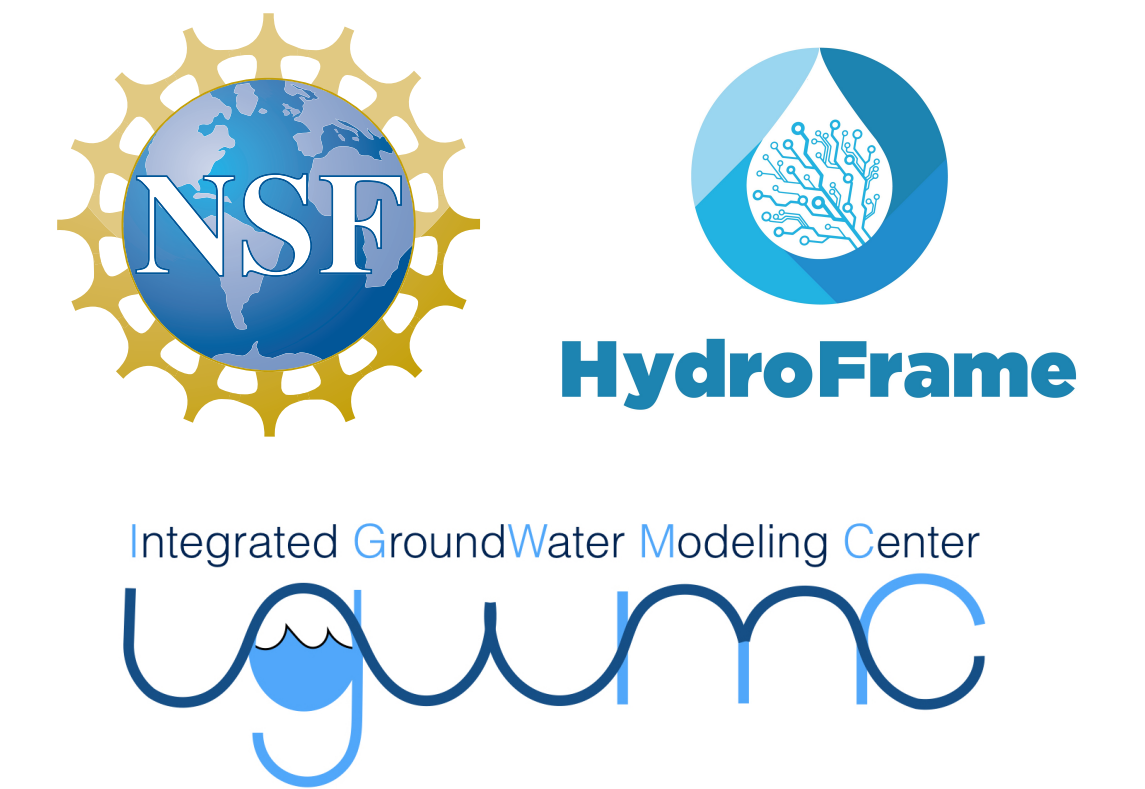


Collaboration for gaming: Partnership between hydrologists, computer scientists, and educators to develop an educational geoscience game



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Introduction:

The Integrated Groundwater Modeling Center is a small research center with a focus on hydrological research and a mission to develop and promote education and outreach in our community. We believe that students of all ages learn better when learning is fun, social, and hands-on. We strive to develop games that will immerse and educate users in geoscience concepts by collaborating closely with computer scientists and software engineers. For the work presented here, we have partnered with the University of Arizona and Kitware, Inc., blending technologies and expertise to develop a game to teach hydrogeology concepts.

We have developed an interactive computer simulation of a physical groundwater model for students. This computer simulation has a game-like web browser-based interface but builds upon open source software components developed by Kitware (e.g. ParaViewWeb) executing the integrated hydrology model ParFlow, using a framework built upon the widely used Python scripting language. Students run the simulation using a familiar web-app like interface with sliders and buttons yet are learning real hydrologic concepts and can compare to the physical model.

Motivation:

HydroFrame (hydroframe.org) is a project motivated to make national hydrologic simulations and associated educational resources more accessible. Our project team recognizes that groundwater plays an integral role in the hydrologic cycle but is difficult to see and therefore often misunderstood or ignored. We hope to change that by developing and making available tools and lessons that allow students to explore how water behaves in the subsurface and beyond.

A large part of our education and outreach lessons utilize physical sandtank models, which are very effective tools and quite popular with students. Although these models are a wonderful educational resource, they do have limitations:

- Require access to physical sandtank models
- Prohibitively high cost to purchase for many educators
- Necessity of trained personnel to deliver instructive lessons
- Required time to visualize hydrogeological phenomena and "reset" system
- Static configuration of model materials

Our virtual slice of the subsurface, the ParFlow Sandtank Model, overcomes these limitations while still allowing educational goals to be met:

- Increases accessibility for users without physical model or instructor
- Free educational tool: user manual and instructional videos provided
- Can "reset" system instantaneously and visualize processes in real-time
- Can configure model in various scenarios based on available templates
- Provides visual and numerical outputs for lesson development

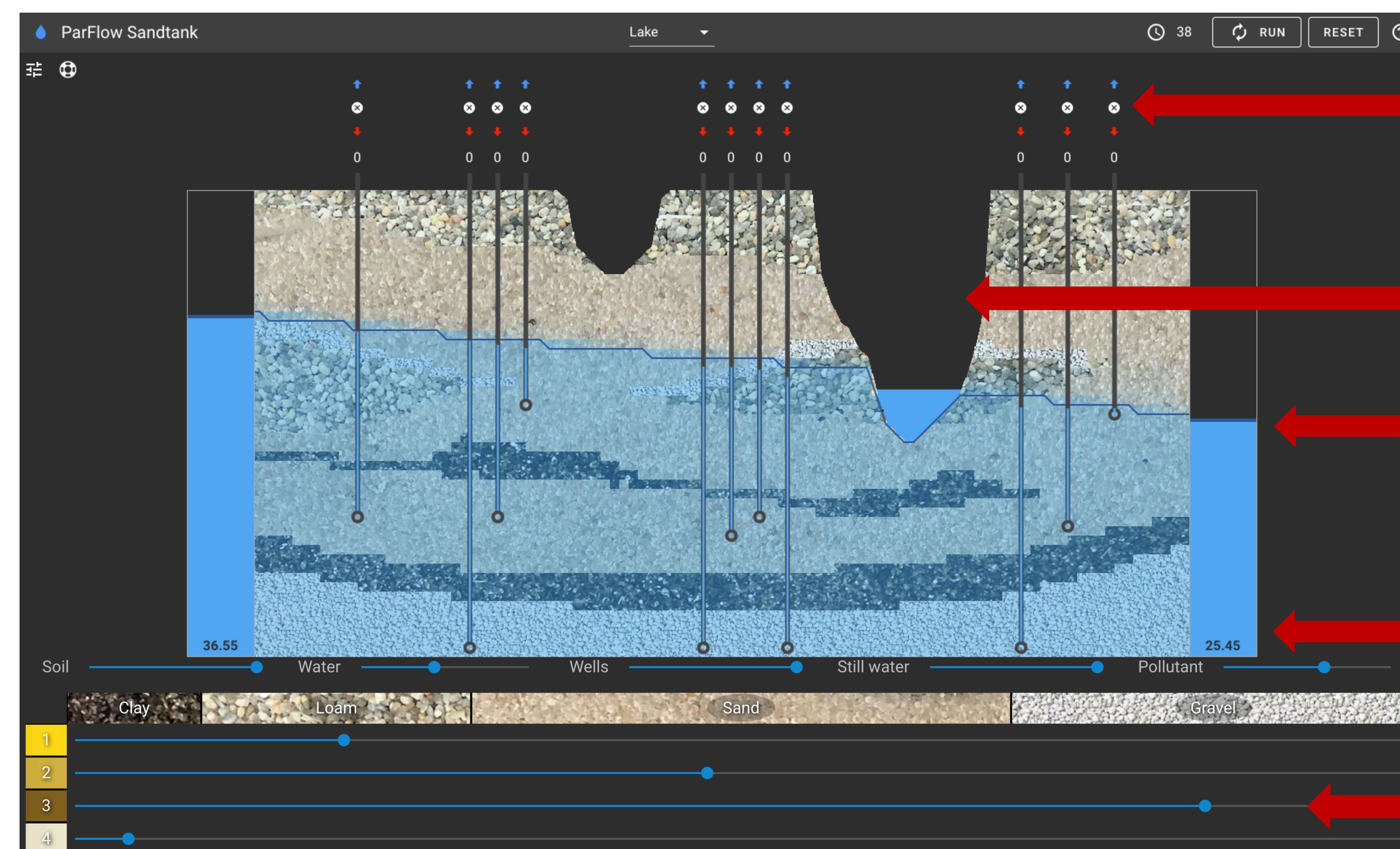
HydroFrame Partners:



Acknowledgement: This material is based upon work supported by the Department of Energy under Award Number(s) DE-SC0019609 – Cloud/Web-based Advanced Modeling and Simulation Turnkey High-Performance Computing Environment for Surface and Subsurface Science and the US National Science Foundation Office of Advanced Cyberinfrastructure under Award OAC-1835855.

The ParFlow Sandtank Model:

Our user interface allows participants to dive into the world of groundwater hydrology, making decisions about inputs to groundwater aquifer systems (hydraulic conductivity, pumping rates, etc.), visualizing outputs (saturation, stream flow, etc.), and learning about various factors that impact real environmental systems. This interactive environment is designed to be used as a stand-alone activity or be paired with additional educational modules and instruction for advanced users.



Ability to pump or inject water – particle injection and tracking when water is injected

Toggle between lake and river feature, with associated outputs

Visual representation of water table

Adjustable water heads

Ability to adjust sandtank materials and permeability values

Gaming and Resources---<https://www.hydroframe.org/groundwater-education-tools>



- Our associated game was developed for students to learn about hydrology concepts in a fun, exploratory way. There are **many** options for game development using this tool and we hope the educational community will flex its creative muscles!
- The HydroFrame website currently provides links to a user manual, an introductory video, and our game/lesson. We are very excited to work with other users to post lessons used or develop new lessons, please contact us! lgallagher@mines.edu
- New lessons and videos will be posted as they become available so please check the website regularly.

Application Workflow:

